

Claims

- [c1] 1. An optical sensor for the characterization or the detection or the detection and characterization of a chemical or bio-chemical substance comprising at least one optical waveguide with a substrate, a waveguiding material, a cover medium and at least one waveguide grating structure, at least two sensing pads comprising at least one unidiffractive or multidiffractive grating, at least one of the sensing pads acting as sensor pad and comprising a sensor chemosensitive or bio-chemosensitive substance, and at least one of the sensing pads acting as reference pad and comprising a reference chemosensitive or bio-chemosensitive substance, light source means for the simultaneous illumination of gratings of the sensor pad and of the reference pad; detection means for detection of positions or of intensities or of positions and of intensities of at least two light distribution proportions, which, on the detection means, are not superimposed on one another and which are emitted or coupled out or emitted and coupled out from the waveguide grating structure into the substrate or into the cover medium or into the substrate and into the cover medium; means for the generation of a referenced sensor signal through the evaluation of the detected light distribution, of the detected positions or of intensities of the at least two light distribution proportions or of a combination of these.
- [c2] 2. The optical sensor according to claim 1, wherein the sensor pad and the reference pad each comprise at least one in-coupling grating and at least one out-coupling grating.
- [c3] 3. The optical sensor according to claim 1, wherein a lens system is arranged between the waveguide and the detection means.
- [c4] 4. The optical sensor according to claim 1, comprising one detector for the detection of the at least two light proportions, said detector comprising means for resolving the positions or the intensities or the positions and the intensities of the at least two light proportions.
- [c5] 5. The optical sensor according to claim 1, wherein the detector is a 1-

dimensional or a 2-dimensional photodiode array or CCD camera or a 1-dimensional or 2-dimensional analogue position sensitive detector or a 1-dimensional or 2-dimensional digital position sensitive detector.

- [c6] 6. The optical sensor according to claim 1 wherein a waveguide grating structure comprises means for producing at least four emitted or out-coupled or emitted and out-coupled light fields corresponding to the forward and the rearward direction of the transverse electric mode and the transverse magnetic mode.
- [c7] 7. The optical sensor according to claim 1 comprising means for conducting at least two of a direct sensing test and of a fluorescence test and of a luminescence test and of a phosphorescence test using only one light source.
- [c8] 8. The optical sensor according to claim 1, wherein the two sensing pads are adjacent to one another.
- [c9] 9. The optical sensor according to claim 1 wherein the two sensing pads are located in one another or one above the other.
- [c10] 10. The optical sensor according to claim 1 wherein the grating or gratings of the sensor pad have the same grating period or grating periods as the grating or gratings of the reference pad.
- [c11] 11. The optical sensor according to claim 1 wherein sensor pad and reference pad differ from each other in the grating period of at least one grating.
- [c12] 12. The optical sensor according to claim 1 wherein at least one grating is situated in a volume or on a bordering surface or in a volume and on a bordering surface of a material contained in the waveguide.
- [c13] 13. The optical sensor according to claim 2, wherein one sensing pad of the waveguide grating structure unit contains two out-coupling gratings and an in-coupling grating situated between the out-coupling gratings, or two in-coupling gratings and an out-coupling grating situated between the in-coupling gratings.

- [c14] 14. The optical sensor according to claim 1, wherein a "well" or a matrix of "wells" is affixed onto the waveguide grating structure or is inserted into the waveguide grating structure.
- [c15] 15. The optical sensor according to claim 1, wherein a flow-through cell or a matrix of flow through cells or a capillary vessel or a matrix of capillary vessels are affixed onto the waveguide grating structure or is inserted into the waveguide grating structure.
- [c16] 16. The optical sensor according to claim 1, wherein at least the reference chemosensitive or bio-chemosensitive layer shows essentially no nonspecific binding.
- [c17] 17. The optical sensor according to claim 1, wherein the two chemosensitive or bio-chemosensitive layers assigned to the two sensing pads manifest a differing specificity.
- [c18] 18. The optical sensor according to claim 1, wherein at least the reference chemosensitive or bio-chemosensitive substance shows essentially no nonspecific binding and no specificity.
- [c19] 19. The optical sensor according to claim 1, wherein the sensor pad and the reference pad are arranged at least partially at a distance from each other.
- [c20] 20. The optical sensor according to claim 1, wherein said chemosensitive or bio-chemosensitive substances comprise dextran, and wherein the specificities of the said chemosensitive or bio-chemosensitive substances of the sensor pad and of the reference pad are different.
- [c21] 21. The optical sensor according to claim 1, wherein at least one of said chemosensitive or bio-chemosensitive substances is dextran essentially without any identification molecules.
- [c22] 22. The optical sensor according to claim 1 comprising at least one capillary vessel in which a specimen may be brought into contact with the waveguide or with the chemosensitive or bio-chemosensitive substance or the chemosensitive or bio-chemosensitive substances or with both, with the waveguide and with

the chemosensitive or bio-chemosensitive substance or the chemosensitive or bio-chemosensitive substances.

- [c23] 23. The optical sensor according to claim 1, wherein said light source means comprises a laser diode.
- [c24] 24. The optical sensor according to claim 2, wherein said in-coupling gratings of said sensor pad and of said reference pad are arranged in a manner that illumination of both in-coupling gratings by one single light beam is enabled.
- [c25] 25. The optical sensor according to claim 24, wherein the grating defines a plane with a first direction (y) parallel to the grating lines and with a second direction (x) perpendicular to said first direction (y), wherein said gratings of said sensor pad and of said reference pad or said incoupling gratings of said sensor pad and of said reference pad lie in immediate vicinity to each other and are spaced in said first direction (y).
- [c26] 26. The optical sensor according to claim 1, wherein said sensor pad and said reference pad together comprise one chemosensitive or bio-chemosensitive substance, to which two different specimen liquids can be brought into contact.
- [c27] 27. The optical sensor according to claim 1, wherein said at least one waveguideing material comprises said bio-chemosensitive or chemosensitive substance or said bio-chemosensitive or chemosensitive substances.
- [c28] 28. The optical sensor according to claim 1 comprising means for the immovable fixation of the waveguide grating structure relative to the light source means and the means of detection for the purpose of carrying out a measurement.
- [c29] 29. The optical sensor according to claim 1, wherein the substrate is made of plastic material.
- [c30] 30. The optical sensor according to claim 1, wherein the substrate is coated by an intermediate layer of low refractive index.
- [c31] 31. The optical sensor according to claim 1, wherein the waveguiding material is

a waveguiding film comprising at least one layer.

[c32] 32. The optical sensor according to claim 31, wherein the waveguiding film comprises at least one layer of high refractive index and one polymer layer.

[c33] 33. The optical sensor according to claim 1, wherein two light distribution proportions show different wavelengths and different polarizations.

[c34] 34. The optical sensor according to claim 1, further comprising a reflection arrangement.

[c35] 35. A sensor chip for the characterization or the detection or for the detection and characterization of a chemical or bio-chemical substance, comprising at least one optical waveguide with a substrate, a waveguiding film, and at least one waveguide grating structure, the substrate comprising a bottom, and said waveguide grating structure being configured such as to form at least two sensing pads, each comprising a chemosensitive or biochemosensitive substance, said waveguiding film not being plane-parallel to the bottom of the substrate.

[c36] 36. The sensor chip according to claim 35, wherein the bottom of the substrate comprises at least one of wedges, prisms, cylinder prisms, spherical lenses, and cylinder lenses.

[c37] 37. The sensor chip according to claim 35, wherein the substrate is made of a plastic material.

[c38] 38. The sensor chip according to claim 35, wherein the substrate is provided with an intermediate layer of low refractive index.

[c39] 39. The sensor chip according to claim 35, wherein the waveguiding film comprises at least one layer.

[c40] 40. The sensor chip according to claim 39, wherein the waveguiding film comprises at least one layer of a high refractive index and one polymer layer.

[c41] 41. The sensor chip according to claim 35, wherein at least one grating structure comprises a UV hardening organic or inorganic material or an UV

hardening organic/inorganic composite.

[c42] 42. The sensor chip according to claim 35, wherein said chemosensitive or bio-chemosensitive substances comprise dextran, and wherein the specificities of the said chemosensitive or bio-chemosensitive substances of the sensor pad and of the reference pad are different.

[c43] 43. The sensor chip according to claim 35, wherein at least one of said chemosensitive or bio-chemosensitive substances is dextran essentially without any identification molecules.

[c44] 44. A sensor chip for the characterization or detection or for the detection and characterization of a chemical or bio-chemical substance, comprising at least one optical waveguide with a substrate comprising a bottom, a waveguiding film, and at least one waveguide grating structure, and said waveguide grating structure forming at least two sensing pads, each comprising a chemosensitive or biochemosensitive substance, each sensing pad comprising at least one in-coupling grating and at least one out-coupling grating, the in-coupling gratings of the two sensing pads being arranged next to each other.

[c45] 45. The sensor chip according to claim 44, wherein the grating defines a plane with a first direction (y) parallel to the grating lines and with a second direction (x) perpendicular to said first direction (y), wherein said gratings of said sensor pad and of said reference pad or said incoupling gratings of said sensor pad and of said reference pad lie in immediate vicinity to each other and are spaced in said first direction (y).

[c46] 46. The sensor chip according to claim 44, wherein the substrate is made of a plastic material.

[c47] 47. The sensor chip according to claim 44, wherein the substrate is provided with an intermediate layer of low refractive index.

[c48] 48. The sensor chip according to claim 44, wherein the waveguiding film

comprises at least one layer.

- [c49] 49. The sensor chip according to claim 48, wherein the waveguiding film comprises at least one layer of a high refractive index and one polymer layer.
- [c50] 50. The sensor chip according to claim 44, wherein said chemosensitive or bio-chemosensitive substances comprise dextran, and wherein the specificities of the said chemosensitive or bio-chemosensitive substances of the sensor pad and of the reference pad are different.
- [c51] 51. The sensor chip according to claim 44, wherein at least one of said chemosensitive or bio-chemosensitive substances is dextran essentially without any identification molecules.
- [c52] 52. The sensor chip according to claim 44, wherein at least one grating structure comprises a UV hardening organic or inorganic material or an UV hardening organic/inorganic composite.
- [c53] 53. A sensor chip for the characterization or detection or for the detection and characterization of a chemical or bio-chemical substance, comprising at least one optical waveguide with a substrate comprising a bottom, a waveguiding film, and at least one waveguide grating structure, the sensor chip comprising an array of capillary flow cells or an array of capillary vessels.
- [c54] 54. A sensor chip for the characterization or detection or the detection and characterization of a chemical or bio-chemical substance, comprising at least one optical waveguide with a substrate, a waveguiding film, and at least one waveguide grating structure, the substrate comprising a bottom, a waveguiding film, and at least one waveguide grating structure, and said waveguide grating structure being configured so as to form at least two sensing pads, each comprising a chemosensitive or biochemosensitive substance, each sensing pad comprising one unidiffractive or multidiffractive grating for use in reflection type measurements.

- [c55] 55. The sensor chip according to claim 54, wherein the grating defines a plane with a first direction (y) parallel to the grating lines and with a second direction (x) perpendicular to said first direction (y), wherein said gratings of said sensor pad and of said reference pad or said incoupling gratings of said sensor pad and of said reference pad lie in immediate vicinity to each other and are spaced in said first direction (y).
- [c56] 56. The sensor chip according to claim 54, wherein the substrate is made of a plastic material.
- [c57] 57. The sensor chip according to claim 54, wherein the substrate is provided with an intermediate layer of low refractive index.
- [c58] 58. The sensor chip according to claim 54, wherein the waveguiding film comprises at least one layer.
- [c59] 59. The sensor chip according to claim 54, wherein the waveguiding film comprises at least one layer of a high refractive index and one polymer layer.
- [c60] 60. The sensor chip according to claim 54, wherein said chemosensitive or bio-chemosensitive substances comprise dextran, and wherein the specificities of the said chemosensitive or bio-chemosensitive substances of the sensor pad and of the reference pad are different.
- [c61] 61. The sensor chip according to claim 54, wherein at least one of said chemosensitive or bio-chemosensitive substances is dextran essentially without any identification molecules.
- [c62] 62. The sensor chip according to claim 54, wherein at least one grating structure comprises a UV hardening organic or inorganic material or an UV hardening organic/inorganic composite.
- [c63] 63. An optical process for the characterization or for the detection or the detection and characterization of a chemical or bio-chemical substance in a specimen by means of a waveguide grating structure containing at least one waveguide grating structure unit, wherein the specimen is brought into contact with the waveguide structure in at least one contact zone comprising a sensor

chemosensitive or bio-chemosensitive substance and a reference chemosensitive or bio-chemosensitive substance, in the waveguide structure in the region of the at least one contact zone, simultaneously exciting at least two light waves through the waveguide grating structure unit or at least one grating of the sensor pad and one grating of the reference pad of the waveguide grating structure unit are illuminated simultaneously, and bringing at least one light wave into interaction with the specimen, wherein the light waves differ in at least one of their polarization, their mode number, their wavelength and of their position on the waveguide grating structure, or the sensor chemosensitive or bio-chemosensitive substance and the reference chemosensitive or bio-chemosensitive substance are different, or where at least one light wave is brought into interaction with a first specimen and a second light wave is brought into interaction with a second specimen; detecting light in at least two differing proportions, which are not superimposed on the detection means and of which at least one proportion originates from the at least one contact zone, generating at least one referenced measured signal by the evaluation of the detected light.

- [c64] 64. The process according to claim 63, wherein the measured signal is generated on the basis of a direct detection.
- [c65] 65. The process according to claim 63, wherein the measured signal is a layer thickness or a change in layer thickness according to the solution of the mode equation for at least one polarization, at least one wavelength and at least one mode number.
- [c66] 66. The process according to claim 63, wherein the measured signal is a layer thickness or a change in layer thickness according to the solution of a linear system of equations for at least one polarization, at least one wavelength and at least one mode number.
- [c67] 67. The process according to claim 63, wherein the measured signal is generated on the basis of a marking detection.

- [c68] 68. The process according to the claim 63, wherein both a measured signal belonging to the direct detection as well as a measured signal belonging to the marking detection are generated.
- [c69] 69. The process according to claim 63, wherein the measured signal is resolved as a function of time.
- [c70] 70. The process according to claim 63, wherein a waveguide structure or a waveguide grating structure is selected in such a manner, that the temperature coefficient of the waveguide structure or of the waveguide grating structure is practically zero with respect to at least one specimen and with respect to at least one measured signal.